AN INVESTIGATION OF HUMAN MENTAL AND MOTOR RESPONSES TO HEAT STRESS

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THESIS

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and
Motor Responses to Heat Stress

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ABSTRACT

An investigation into the physiological reactions of persons being artificially acclimatized to extreme heat conditions in an environmental chamber was conducted. While the subjects were being artificially acclimatized they performed low-skill tasks. Their performance was compared to that attained outside of the chamber after acclimatization. Parameters measured were pulse rate, oral temperature, decision making rate, time on target, and two different reaction times. Analysis of the extracted data indicated a correlation between the decision making task and the pursuit rotor task and showed that each of these was correlated with oral temperature. Also, results suggested that the process of artificial acclimatization had not adversely effected the abilities of the subjects to later perform in a "normal" environment.

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I. INTRODUCTION

Man's adaptation to an ever changing environment has caused inquires in a multitude of scientific fields. These inquiries have produced some knowledge of how individuals mentally and physically react and adjust to a variety of pressures. One enlightening and somewhat popular field of study has been concerned with the physiologial responses of man under conditions of extreme heat. Degradation to performance as a direct result of heat stress has been acknowledged by many researchers (Teichner and Wehrkamp, 1954; Lyman, 1950; Mackworth, 1946; Pepler, 1958, 1960; Russell, 1957; among others). However, other researchers have not observed this degradation (Chiles, 1968 and Loeb and Jeantheau, 1958). The degradation of performance to a lesser degree in an acclimatized individual working under heat stress has also been noted (Edholm, et al, 1963). Degradation of performance is generally compounded with time under heat stress, so, as a precaution, it is usually procedural to remove persons to a more favorable environment after a period of time which is dependent upon the amount of stress placed on the individual. This is a precautionary measure since prolonged exposure might subject one to possible physiological damage caused by the induced hyperthermia.

Until recently, the U.S. Navy has not had standards for determining maximum exposure to a heat stress environment. It was generally accepted that men working in areas of elevated temperature such as shipboard engine rooms, laundries and sculleries were operating under heat stress, and, therefore needed frequent breaks from the environment. The U.S. Navy has officially recognized this need for a relief from the heat stress and has

recommended that persons removed from an environment of high heat stress should remain in an area of no heat stress for four hours or a period equal to twice the exposure time, whichever is less (NAVSHIPS Note 5100). An area with little or no heat stress is one with a wet bulb globe temperature (WBGT) of less than 85°F and is herein referred to as a "normal" environment. WBGT is defined as .7WB+.2GT+.1DB where WB, GT, and DB are the wet bulb, globe, and dry bulb temperature respectively (Leithead and Lind, 1964).

The immediate supervisor of persons working under heat stress should recognize the inability of his workers to perform at sustained high performance levels for prolonged periods of time. He should therefore take necessary corrective measures to insure that his objectives are reasonable in light of this additional constraint. What is not so evident is the question of whether or not the supervisor should expect a lower than normal performance from a worker performing in a "normal" environment immediately upon removal from work under extreme heat conditions.

Aboard ships many persons are required to work at various levels of skill in both hot and normal environments under the same supervisor. And since no one person is expected to perform a full work day in an extreme heat condition, he is usually alternated through a hot and a "normal" work environment. These persons then become acclimatized to the hot environment, after a period, usually ten to twelve days, of exposure (Edholm, et al 1963, Humphreys, et al 1946, Leithead and Lind, 1964, and Lind and Bass, 1963). After acclimatization, the performance of these persons should then be expected to approach a level of achievement which would vary from person to person dependent upon natural ability, but, nevertheless, a level of achievement superior to the unacclimatized individuals attainment.

The purpose of this paper is to (1) analyze the mental and motor performance capabilities of persons performing low-skill tests while being artificially acclimatized to extreme heat, and, (2) to determine if the process of acclimatization significantly affects the performance of an individual after he has been removed from the hot environment. Some insight should be gained into whether one can perform in a "normal" environment as well after he has been acclimatized to extreme heat as before the process began.

II. METHOD AND PROCEDURES

The investigation was conducted in a 7 x 7 x 7 foot environmental chamber with an average WBGT of 88.63°F and air movement less than 10 f.p.m. Three subjects were used for the test. Subject A was the experimenter. Subjects B and C were monetarily compensated for their time. The sample size was small, but necessary, due to space, time, and monetary constraints. Because of the length and nature of the experiment it was not possible to obtain volunteers for the experiment.

Subject A was 35 years of age, and was conducting this experiment as a partial requirement for a Masters degree in Operations Research.

Subject B was 22 years of age, a high school graduate, and an enlisted seaman in the U.S. Navy.

Subject C was 17 years of age, a high school graduate, and on summer vacation from school.

All subjects were residents of the Monterey Peninsula where the mean ambient temperature for the previous three months had been below 70°F. None of the subjects had recently been exposed to any temperatures which would induce natural or artifical acclimatization and none had previously performed any of the tasks related to the investigation.

All subjects were continually cautioned to maintain a regular meal schedule and to get 8 hours of sleep each night.

The subjects entered the environmental chamber at the same time each day for ten days and remained therein for 100 minutes. Before entering the chamber each subject had his weight, oral temperature, and pulse rate recorded. Additionally, each was questioned as to his general well being

to insure that his performance was not biased by some external health problem. Each subject wore dungaree trousers, a white undershirt, and street shoes. This dress is comparable to that worn in spaces of extreme heat aboard ships of the U.S. Navy.

When the subjects entered the chamber the wet bulb, and globe temperatures of the chamber were recorded. A psychrometer was used to measure the wet and dry bulb temperatures. The globe temperature was read from a mercury thermometer incased in a size number 10 flat black painted tin can. The subjects were then rotated through two two-minute intervals on a treadmill with four minutes of rest between each period on the treadmill. The treadmill was set to zero inclination and one mile per hour speed on the first day. The second day the inclination was increased to one percent grade and speed to 1.2 m.p.h. Each day thereafter the inclination was increased 2% and the speed .2 m.p.h., until the 10th day at which time the speed was up to 2.8 m.p.h. and the inclination set at 17% grade. The increased workload each day was a necessary part of the acclimatization procedure (Bean and Eicha, 1943; Consolazio et al, 1963; Eicha et al, 1945; and Fox, 1960).

Since initially the sweat producing mechanisms of the body are not properly adjusted to handle the increased heat load, a greater strain is placed on the thermoregulatory system the first few days, therefore the work load was lightest during those days. The treadmill exercise time also allowed the body tissue temperature to reach threshold values before commencement of the performance evaluation tests (Lind and Bass, 1963).

After completion of the treadmill exercise the subjects were rotated through a decision making task. The task was an adaptation of that described by Poock (1967) and was used to obtain the rate at which a

person can process information. The parameters used for determining a measure of decision making ability were (1) the cumulative time in thousandths of a second to make 40 two-bit decisions; and (2) the cumulative time in thousandths of a second to make 40 one-bit decisions. Poock (1967) defines one bit of information as the amount of information that one needs to make a decision between two equally likely alternatives and two bits of information as the amount of information needed to make a decision among four equally likely alternatives.

The decision making task was designed so as to demand the continuous attention of the subject. It required the subject to place both hands palm down onto a metal control box. The box had four buttons labeled 1-4 from left to right. The middle and index fingers of the left hand were placed on the 1 and 2 and the index and middle fingers of the right hand on the 3 and 4, respectively. The subject was then required to observe a small screen placed directly in front of him and at the level of his hands. Onto the screen would appear the number 1, 2, 3, or 4. The subject was required to press the appropriate button immediately upon recognition of the number which appeared on the screen.

The presentation of the numbers was controlled from another four button control box. The four numbers 1, 2, 3, and 4 appeared 40 times at one-second intervals for the two-bit test. The numbers 2 and 3 appeared 40 times at one-second intervals for the one-bit test. An electronic timer was attached to the unit and accumulated the total response time for each test.

The total response time for the one-bit test was subtracted from the total time for the two-bit test. This time difference was then inverted to get the decision processing rate.

After the decision making test had been completed by all of the subjects the wet bulb, dry bulb, and globe temperature of the chamber were again recorded. The oral temperature and pulse rate of each subject was also recorded, after which each was given four ounces of water as a dehydration preventative. Immediately upon conclusion of the data recording the subjects were rotated through five 30-second tests on a pursuit rotor.

The pursuit rotor task was used to obtain a variation in the psycho-motor ability of a person under heat stress. The parameter used for determining a measure of psycho-motor ability was the cumulative time that the subject was able to maintain a wand on a target light in a 30-second interval. This time was measured in hundredths of a second.

The rotor required the continuous attention of the subject. The subject was placed in a chair directly in front of a control unit. The top of the control unit, at about waist height, was all glass and had been painted black except for a portion which described an equilateral triangle. Under the glass top and offset from the center there was a white light beam which rotated at an adjustable speed. This combination then presented to the subject a square of white light which travelled counter-clockwise around the triangle. The subject was given a photoelectric wand, the tip of which he was required to maintain on the light as it rotated about the triangle. Because the light was offset under the triangle it travelled at a constantly variable speed and consequently passed each of the three angles at different speeds. This presented quite a challenge to the subjects as they had to be constantly readjusting the wand speed in order to remain on the light.

Attached to the unit was an electronic timer which accumulated the amount of time that the subject was able to remain on target. A stop watch was used to start and stop the 30-second test interval and the light speed was set for a constant 22 revolutions per minute.

Because of the inaccuracies involved with using the stop watch to start and stop the test, and in order to obtain a reasonably accurate test of ability to remain on target during a 30-second test, it was repeated five times with 30 second rest periods between each test.

After all subjects had completed the pursuit rotor test they were 70 minutes into the exercise. At that time recordings were again taken and water consumed in the same manner as described previously. The remaining time in the chamber consisted of rotating the subjects through three two-minute intervals on the treadmill. Each subject had his pulse rate monitored upon conclusion of each turn on the treadmill to insure of no adverse reaction. Subject B performed only one turn on the treadmill on the tenth day because his pulse rate was an unusually high 140 beats per minute upon conclusion of his first turn on the treadmill.

During their stay in the chamber each subject was questioned periodically as to his subjective feelings. Each having been informed that if at any time he did not feel well he could leave the chamber. No subject had to be removed from the chamber at any time during the ten day experiment.

Upon departure from the chamber each subject was weighed to insure that no unusual loss of liquid had occurred.

Immediately after the tenth day of exposure to the chamber environment each subject was given the performance tests in a "normal" environment of 61°F WBGT. These same tests were performed again after 24 hours had elapsed.

Two days before the chamber tests commenced, each subject had been rotated through the performance tests to familarize themselves with the equipment and procedures as well as an attempt at reducing the expected learning effect. One day before the chamber tests commenced each subject was rotated through the performance tests and baseline data at 61°F WBGT was recorded. A total of 13 observations were recorded; number one the day before entering the chamber, numbers two through eleven while in the chamber, number twelve immediately after leaving the chamber on the tenth day, and number thirteen 24 hours after the final day in the chamber.

It should be noted that the pursuit rotor test provided psycho-motor activity, whereas the decision making test was essentially cognitive in character since the motor component was extremely small.

III. RESULTS

The subject's mental and motor performance was evaluated by measuring (1) his rate of decision making (DMR), (2) his total time on target (PRT), (3) his total response time to make 40 one-bit decisions (1-bit), and (4) his total response time to make 40 two-bit decisions (2-bit). The subject's average pulse rate and oral temperature were also recorded at each observation. Table I gives the averages of the thirteen data points recorded and Figures 1 through 4 are graphs of those averages. Observations 1, 12, and 13 were taken at "normal" temperature where the WBGT was 61° F. Observations 2 through 11 were taken in the environmental chamber where the WBGT fluctuated between 87.630° F and 89.879° F with a mean of 88.630°F.

TABLE I. Average Value of Variables

Observation	WBGT (°F)	DMR (Bits/Sec)	PRT (Sec)	1-bit (Sec)	2-bit (Sec)	Oral Temp. (°F)	Pulse (Beats/Sec)
1	60.980	.2031	22.782	18.621	23.580	98.67	76.83
2	89.090	.2438	22.497	18.472	22.983	100.33	93.00
3	87.615	.1845	23.349	17.058	22.490	99.28	91.50
4	87.890	.1766	24.049	16.806	22.389	99.18	87.83
5	88.240	.2038	24.949	16.851	21.802	99.03	90.33
6	89.180	.1943	25.490	16.335	21.491	99.42	95.00
7	87.188	.2204	24.939	15.359	19.920	99.21	87.33
8	89.608	.2750	25.799	16.554	20.718	99.28	87.67
9	89.879	.2255	25.877	15.641	20.167	99.26	90.83
10	89.393	.2313	25.525	15.794	20.294	99.16	94.50
11	88.225	.2773	25.672	14.795	18.473	99.18	95.83
12	61.00	.3191	28.168	14.602	17.755	99.00	84.00
13	61.00	.2651	28.166	15.536	19.508	98.60	75.33

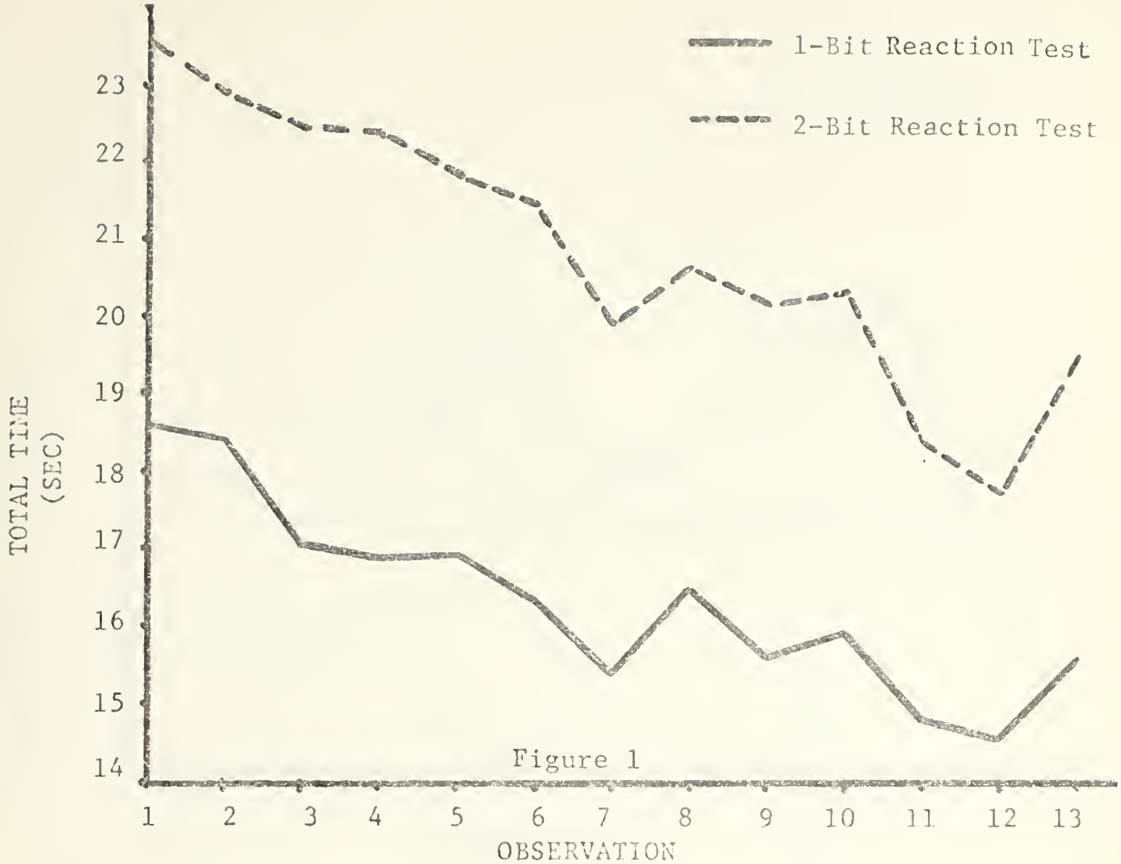

Figure 1

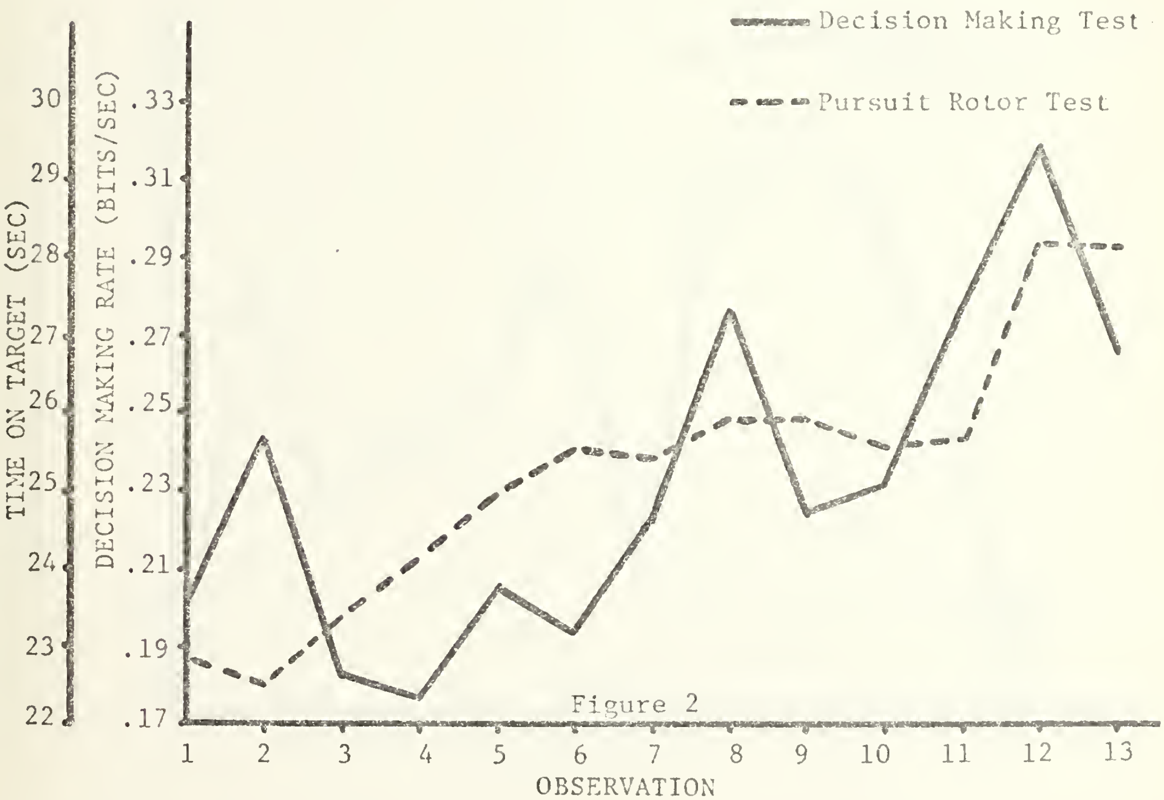

Figure 2

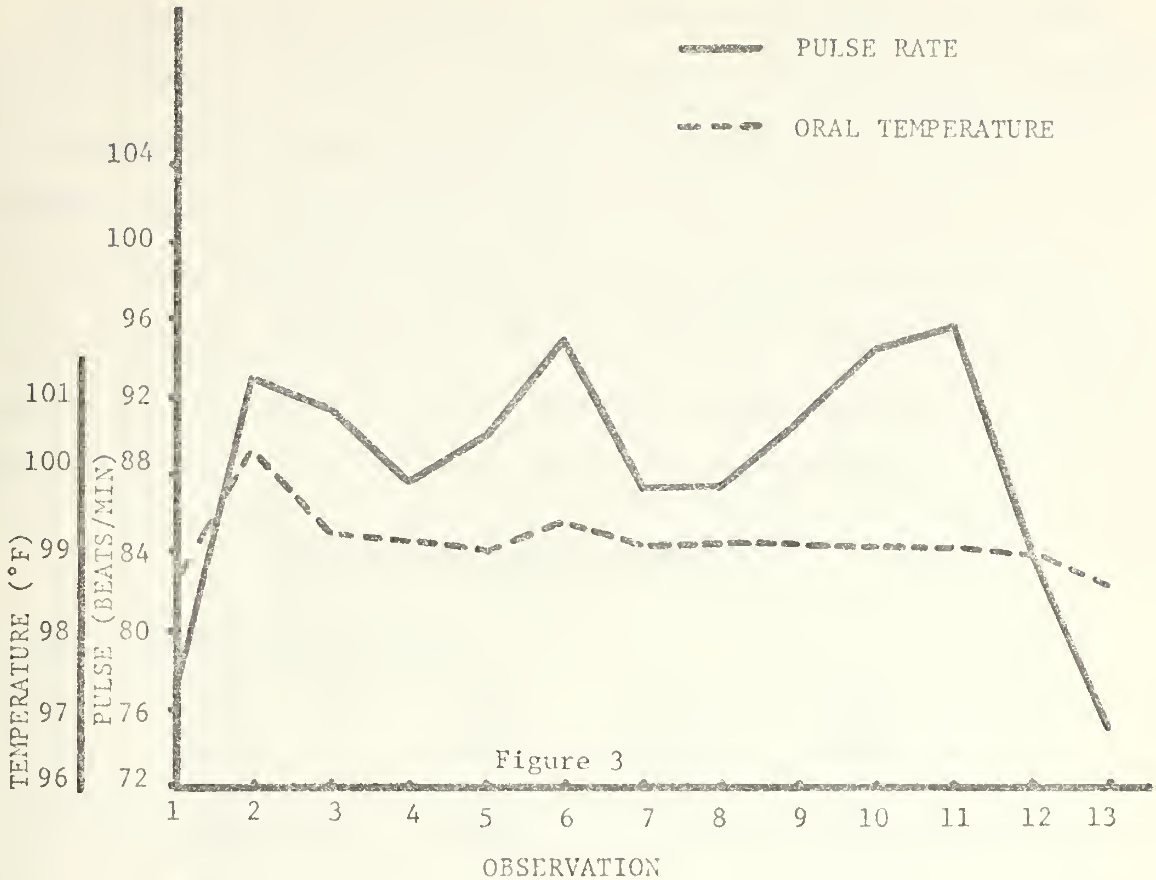

Figure 3

Figure 4

A two-way analysis of variance, a stepwise regression, and a simple linear correlation analysis of the performance and physiological variables were computed. The analysis was accomplished with the assistance of the SNAP/IEDA Computer Package User's Manual (1972).

The two-way analysis of variance was performed on each performance and physiological variable as a test for significant differences between subjects and treatments. As can been seen in Table II there was a significant difference in all instances at the .05 alpha level.

TABLE II. Analysis of Variance

Variable: Decision Making Rate

Source	SS	DF	MS	F	P
Subjects	.0172	2	.0086	4.6827	.0192
Treatments	.0639	12	.0053	2.9016	.0127
Error	.0440	24	.0018		
Total	.1251	38			

Variable: Pursuit Rotor Time

Source	SS	DF	MS	F	P
Subjects	64.0031	2	32.0016	52.6406	0.0000
Treatments	110.5964	12	9.2164	15.1603	0.0000
Error	14.5902	24	0.6079		
Total	189.1897	38			

Variable: One-Bit Response Time

Source	SS	DF	MS	F	P
Subjects	36.9510	2	18.4755	19.3195	0.0000
Treatments	55.7786	12	4.6482	4.8605	0.0005
Error	22.9516	24	0.9563		
Total	115.6812	36			

Variable: Two-Bit Response Time

Source	SS	DF	MS	F	P
Subjects	38.7685	2	19.3842	18.9413	0.0000
Treatments	111.1465	12	0.2622	9.0506	0.0000
Error	24.5612	24	1.0234		
Total	174.4761	36			

Variable: Pulse Rate

Source	SS	DF	MS	F	P
Subjects	1382.809	2	691.4043	31.4554	0.0000
Treatments	1506.852	12	125.5710	5.7128	0.0000
Error	527.531	24	21.9805		
Total	3417.191	38			

Variable: Oral Temperature

Source	SS	DF	MS	F	P
Subjects	5.7539	2	2.8769	19.0169	0.0000
Treatments	6.1758	12	.5146	3.4037	0.0145
Error	3.6289	24	.1512		
Total	15.5586	38			

A Duncan's Multiple Range Test (Bruning and Kintz, 1968) was used to determine where the differences occurred among the thirteen treatments.

The results clearly indicated the significant differences were primarily in regards to observations in the environmental chamber, numbers 2-11, versus observations in the "normal" environment, numbers 1, 12, and 13.

Table III is the linear correlation matrix applicable to the performance and physiological variables.

TABLE III. Linear Correlation Matrix

	DMR	PRT	WBGT	ORAL TEMP.	PULSE	1-Bit	2-Bit
DMR	1.00						
PRT	0.47	1.00					
WBGT	-0.28	-0.27	1.00				
ORAL TEMP.	-0.34	-0.43	0.50	1.00			
PULSE	0.16	-0.04	0.60	0.01	1.00		
1-Bit	-0.18	-0.09	0.02	-0.22	0.08	1.00	
2-Bit	-0.58	-0.30	0.15	-0.01	-0.02	0.90	1.00

Using a Pearson Product-Moment Correlation (Bruning and Kintz, 1968) coefficient of .3000 for 38 degrees of freedom and a .05 alpha level of significance the underlined values in the above matrix indicate significant correlation between the applicable two variables. This significance in naturally dependent upon an assumption that the relationship in linear and the variables are normally distributed.

The significant correlation between oral temperature and pulse rate to the chamber temperature agree with the findings of Humphreys, et al (1946) and Viteles and Smith, (1946). Whereas Azer, et al, (1972) and Pepler, (1958) indicate no significant correlation of physiological measures to deterioration of performance, the above clearly indicated a correlation of oral temperature to the two performance variables, Decision Making Rate and Pursuit Rotor Time.

One possible explanation for this behavior is in the experimental criteria used for performance measurement. The decision making test was

a mental test as opposed to the psycho-motor tests conducted by Azer and Pepler. And, though the pursuit rotor test was a psycho-motor test it differed from Azer and Pepler in that it accumulated total time on target and ignored the number of times the subject was off target and his reaction time to get back on target which were measures of performance used by Azer and Pepler. The oral temperature did not correlate with either of the response (reaction) variables used in the decision making test, and the other physiological measure, pulse rate, did not correlate to any of the performance variables. Both substantiate the findings of Azer and Pepler.

Learning was a factor to be considered in the investigation. All subjects were trained and tested on the performance tests prior to the first observation, however, it was obvious from the data that each subject's performance improved daily. How much of the improvement was learning and how much was because of the effects of acclimatization was not clear. It should be reasonable to assume that the one-bit response test was not as susceptible to learning effect as the two-bit response test because of its relative simplicity. Owing to this assumption the significant correlation of the two-bit test to both the mental and motor tests can be explained away as a result of the learning effects experienced with these tests.

The extremely high correlation between the one-bit and two-bit tests was natural in that they were both measures of response time. The correlation might possible have been higher if not for the difference in the learning .rate.

The most significant results appearing in the correlation matrix was the relationship exhibited between the mental and the motor performance

variables. Figure 5 is a graphical representation of the two variables at each of the thirteen observations. How much of the rise in performance over the thirteen observations was directly attributable to the acclimatization is not clear. However, figure 5 indicates a significant jump in the graphically presented performance ability after observation number 4 which tends to support the supposition that the subjects were beginning to adapt to the new environment. Any learning effect could not have been expected to cause such a distinct jump in performance. The best performance was observed during the last two observations while the subjects were performing in the "normal" environment. The distinct superiority of performance ability indicated at observations 12 and 13 again substantiate the results of the Duncan's Multiple Range Test.

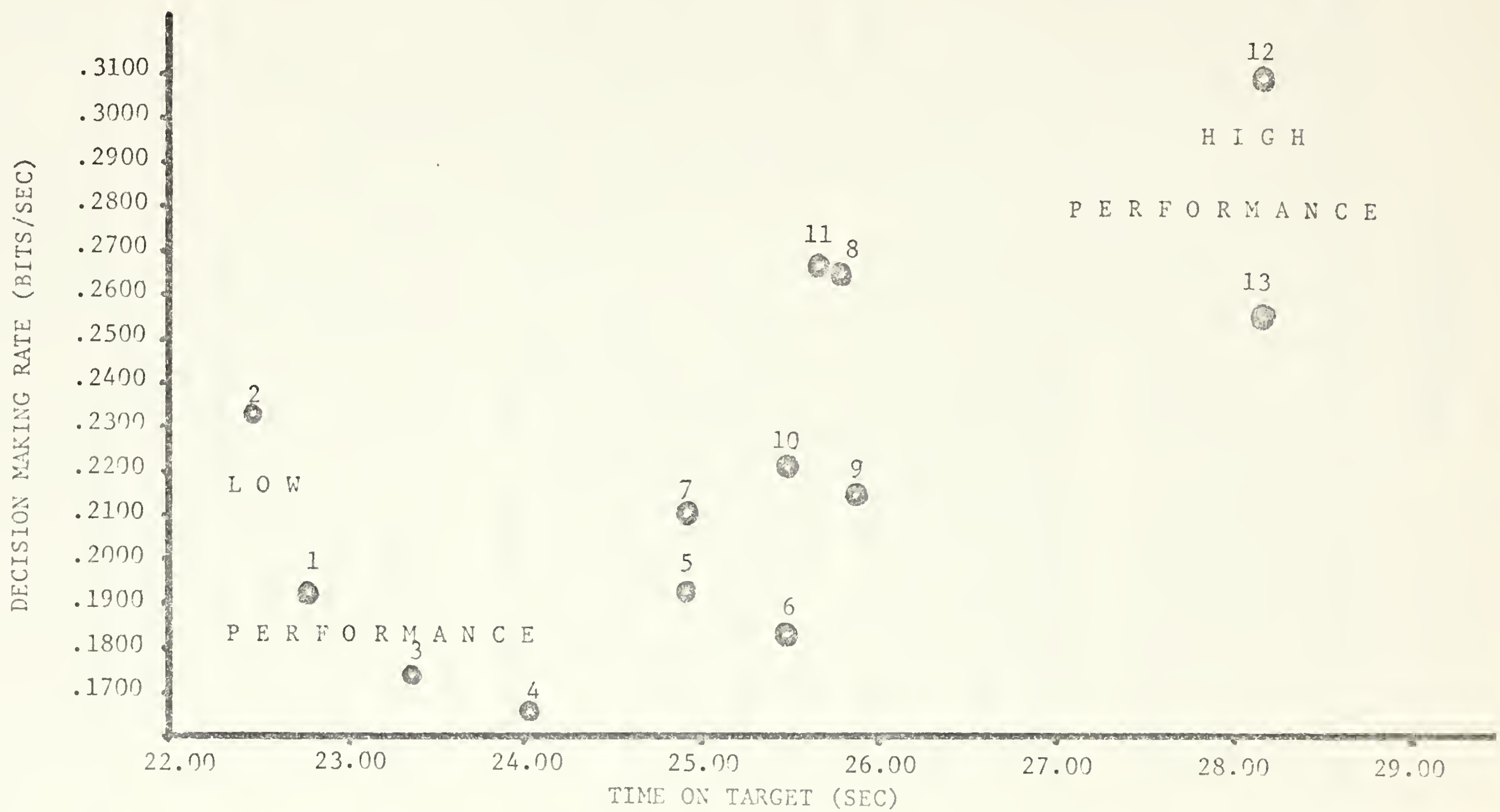

FIGURE 5 DECISION MAKING RATE VERSUS PURSUIT ROTOR TIME.

IV. CONCLUSIONS

Significant correlations between the oral temperature and the performance tasks, both mental and motor, of persons being artificial acclimatized were revealed in the results of the investigation. Additionally, a significant correlation was found between the mental performance task and the psycho-motor performance task.

Evidence was presented which supported the supposition that a person removed from working in an area of extreme heat can be expected to continue his work without detriment in a "normal" environment. However, more investigation needs to be done in this area since these results are based on performance data at only two observations. The first data point observed after removal of the subjects from the chamber showed considerably better performance than the next data point which was observed after a 24 hour rest period. Gagge (1968) states that when one is removed from a hot environment to a comfortable environment he is comfortable dispite his body temperature reflecting otherwise. Grieve (1960) implies that it is the uncomfortable conditions caused by heat that induces the loss of efficiency. Pepler (1960) states that the degraded performance may be due directly to the level of warmth or to the distracting effect of the strange conditions. All of these indicate that there are subjective factors involved in the performance degradation as well as physiological factors. A possible reason for the sharp rise in performance at observation number 12 could be the removal of the subjective discomfort which helped to induce better performance. After the subjects had been removed from the chamber for 24 hours and observed again there was no subjective

feeling of improved comfort so the subjects performed at a somewhat lower rate than the previous day.

Because of the tight resource constraints the investigation was necessarily conducted with a smaller sample size and fewer observations than desired by the investigator. Two larger groups of subjects should have been used with extensive pre-training to eliminate all traces of the learning effects. One group should have conducted the same test as another group in the environmental chamber in order to obtain a better understanding of the effects of the acclimatization on performance. Once acclimatized, the subjects should have been tested extensively to get a better comparison of performance after acclimatization to before acclimatization.

Humidity is one of the factors generally considered by researchers in the study of the effects of heat stress on performance (Azer et al, 1972; Humphreys et al, 1946; Mackworth, 1947; Pepler, 1958; and Weiner and Hutchinson, 1945.) In this investigation the humidity was very low and consequently not considered as having any effect on the performance of the subjects.

For a more realistic comparison of conditions actually existing in firerooms, sculleries and laundries aboard ships of the U.S. Navy the investigation should have included the effects of humidity and radiation.

The heat generated in a fireroom, scullery or laundry emanates primarily from extremely hot surfaces of various shapes and sizes. This radiated heat contributes significantly to the heat stress within the space. The radiation factor was extremely low in the environmental chamber used for this investigation. Gagge et al (1964, 1967, and 1968)

and Rapp (1967) have demonstrated the importance of the shapes of surrounding objects in the vicinity of a worker in the computations of the radiant heat effects on the comfort of man.

Bean and Eicha (1943) have stated that acclimatization is indicated by a lower pulse rate and oral temperature. With the data obtained from the investigation, acclimatization was not explicitly evident. The data did show a slight trend which implied that acclimatization was being affected. Electrodes attached to the subjects to continuously monitor their physiological responses would have aided in indicating when acclimatization had been accomplised.

NASA Contractor Report 1205 (1968) indicates significant rises in pulse rate and oral temperature start to occur at effective temperatures greater than 88°F. Effective temperature integrates wet bulb, dry bulb and air movement and can be computed via nomographs such as those in NASA Contractor Report 1205. Conversion of WBGT to effective temperature indicates that the investigation was conducted in a range of effective temperatures in the chamber from 84°F to 89°F. This implies that in order to insure acclimatization by observation of a pulse rate decline, the environmental temperature should have been set at values greater than 88°F effective (89°F WBGT). (These values are all computed with air velocity less than 20 f.p.m.) The danger of a subject being seriously effected by the heat stress was considered and the WBGT was necessarily held down to prevent any complications.

In summary, investigations into the physiological responses of man under conditions of extreme heat have been going on for many years. Each investigation has been a small step in the direction of providing a better environment in which man may live. The experimentation is usually tedious,

requires unique instrumentation and is sensitive to experimental design. However, with ever expanding knowledge and facilities and the availability of more sophisticated equipments there should always be the necessary initiative to expand investigation of man's physiological responses to stimuli. Nevins (1968) states that thermal comfort and human physiological research are a necessary part of our society and recognizes the challenge to provide a more comfortable and economic environment for the welfare of mankind.

APPENDIX A

Experimenter's Instructions for the Decision Making Task

1. This is an experiment designed to measure your decision making ability in response to stimuli.

2. You may have your own ideas about an experiment of this type but you are asked to forget all that you know or have heard and follow instructions as presented to you.

3. In the experiment you will be seated and asked to place the index and middle finger of both your left and right hands onto four buttons number from left to right 1, 2, 3, and 4. You will also be asked to visually observe a screen placed directly in front and at the same level as your hands.

4. At the beginning of the task, you will be alerted by the verbal signal "Ready." Next, you will observe the number 1, 2, 3, or 4 appear on the screen. Upon recognition of the number immediately, and as rapidly as possible, completely depress the same numbered key upon which one of your fingers rests.

5. If you have depressed the correct button then the number appearing on the screen will disappear and momentarily another will appear at which time you will again completely depress the corresponding button. This procedure will continue until you are informed that the task has been concluded.

6. If you make a mistake and depress a wrong button, as quickly as possible correct your error by depressing the correct one. The number on the screen will not disappear until the correct response is made.

7. During the test you are asked to make yourself comfortable and to respond as rapidly as possible. Please do not try to outguess or anticipate the experimenter as you undergo the task. Each number appearing has been randomly selected and has equal probability of appearing.

8. If at any time during the experiment you are prevented from performing your best effort, due to some external influence immediately inform me of this fact. You will be permitted trial runs in order to familiarize you with the equipment and procedures.

9. Thank you for your assistance. Do you have any questions?

APPENDIX B

Experimenter's Instructions for the Pursuit Rotor Task

1. This is an experiment designed to test your psycho-motor abilities and is commonly referred to as the pursuit rotor test.

2. You may have your own preconceived ideas about an experiment of this type but you are asked to forget all that you know or have heard and follow instructions as presented to you.

3. In this experiment you will be seated directly in front of a control box. On top of the control box at approximately waist height you will see an equilateral triangle with one angle pointed at you and moving counter-clockwise on the perimeter of the triangle you will see a spot of white light. You should note that the light is not travelling at the same rate on all sides of the triangle.

5. A wand will be placed in your right or left hand as appropriate. The tip of the wand will be placed in the near right corner on top of the control box.

6. To begin the task you will be alerted by the verbal signal "Ready" when the light is at the angle furtherest from you and to your left. You will be given a verbal signal "Go" when the light next reaches the same point. That is, after one complete revolution.

7. At the signal "Go" move the tip of the wand to the light and hold it on the light as it moves around the triangle. Any time that the wand tip moves from on the light you must get back on the light as rapidly as possible.

8. After 30 seconds have elapsed you will be given the verbal signal "Stop." At that instant immediately move the wand tip back to its starting position, the near right corner on top of the control box. This procedure will be repeated for 5 consecutive tests.

9. During the task you are asked to make yourself comfortable and to make every effort to maintain the wand tip on the moving light as long as possible. Your total time on the light will be announced to you and you are expected to try and improve on each succeeding test.

10. If at any time during the tests you are prevented from performing your best effort due to some external influence immediately inform me of this fact. You will be permitted trial runs in order to familiarize you with the equipment and procedures.

11. Thank you for your assistance. Do you have any questions?

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An investigation into the physiological reactions of persons being artificially acclimatized to extreme heat conditions in an environmental chamber was conducted. While the subjects were being artificially acclimatized they performed low-skill tasks. Their performance was compared to that attained outside of the chamber after acclimatization. Parameters measured were pulse rate, oral temperature, decision making rate, time on target, and two different reaction times. Analysis of the extracted data indicated a correlation between the decision making task and the pursuit rotor

task and showed that each of these was correlated with oral temperature. Also, results suggested that the process of artificial acclimatization had not adversely effected the abilities of the subjects to later perform in a "normal" environment.

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